Charles Law Lab

Purpose:
- To observe the relationship between temperature and volume in gases
- To find the experimental volume of a gas at a temperature of absolute zero

Materials

Hot plate 1000-mL beaker 250-mL beaker 100-mL graduated cylinder	cylinder Balloon Thermometer Marker

Safety:
- Avoid touching the Bunsen burner while heating and always use heat-resistant gloves to pick up the warm beaker.
- Wear safety goggles during entire lab.

Procedure:
1. Inflate and seal a balloon to the size of a baseball. Knead the balloon a little to reduce the elasticity of it.

2. Add about 600 mL of water to your 1000-mL beaker, marking its level with an erasable marker (the exact volume of water here is not important- just the water level). Record the exact temperature of the water in the Data Table.

   Kelvin = °C + 273

3. Place the balloon in the beaker of water at room temperature. Using the bottom of the 250-mL beaker, depress the balloon until it is submerged below the level of the water. Avoid submerging any portion of the beaker, as this will falsely increase the volume of the balloon to be recorded.

4. Allow the balloon to remain submerged for at least 60 seconds to allow the temperature of the air in the balloon to achieve the temperature of the water in the beaker. While the balloon is still immersed, record the new water level using a marker.

5. Remove the balloon from the beaker.

6. Using a graduated cylinder and measuring carefully, fill the large beaker with additional water to achieve the level obtained when the balloon was originally submerged. Record the volume of the water added in the data table. (**This represents the volume of the balloon at that temperature**.)

   Your group may choose to do #7 or #8 first- its does not matter.

7. Using ice to lower the temperature of the water by various amounts, repeat Steps 2 – 6 to obtain data for the volume of a gas for at least two lower temperatures. Be sure that there is no remaining solid ice in the beaker when you immerse the balloon.

8. Using the water from a hot plate to raise the temperature of the water by various amounts, repeat Steps 2 – 6 to obtain data for the volume of a gas for at least two higher temperatures.

9. Be sure you have at least 5 pairs of data recorded that **create a clear pattern** and then rinse and dry all materials. (If they do not create a clear pattern you will need to redo some of your points – ask your teacher which points you should redo.

Data:

Temperature (°C) (to nearest 0.1°C	Temperature (K)	Volume (mL) (to nearest 1 mL)

Calculations:

1. Construct a graph of volume (y-axis) versus temperature (Kelvin) (x-axis) describing the relationship that exists between the data points. Read all of the suggestions below before you begin!
    a. Since we are graphing the temperature values in Kelvin, they will be very large and cause the graph to have lots of empty space between the points and the origin… that is OK!
    b. Space your values so most of the space on the page is utilized.
    c. Label the x and y axis and include units that each value is measured in.
    d. Add a "best-fit line" through your points using a ruler. <u>Do not "connect the-dots".</u>
    e. The lowest value (minimum) on the x and y axis should both be 0.

2. Use your graph to determine the temperature at which the volume of air would be zero.
    a. Extend your "best-fit line" until it crosses the x-axis (where y=0).
    b. Determine the temperature at the point.

3. Convert the value for question 3 into Kelvin

4. Compare the experimental calculation of what temperature the gas would have at a volume of zero to the Celsius temperature for absolute zero by using percent error.

5. Using the best fit line you drew for your graph, determine what the volume of the balloon would be at 10°C. (Remember, your graph is plotted in Kelvin)

6. Using your graph, determine the temperature that the balloon would be at if it had a volume of 100.0 mL.

Discussion:

1. What happens to the density of the gas as the temperature rises? Explain.

2. Propose an equation that would represent how to quantitatively determine how changes in temperature would affect volume and vice versa. (Think back to Boyle's Law)

3. What do you think created the most error in your experiment? Describe at least two changes that could have been made to make the results better.